Monitoring of Aquatic Invasive Species in the Central & Arctic Zone

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ABSTRACT

Monitoring of aquatic invasive species (AIS) directly addresses one of the key activities outlined in the Implementation Strategy of the National Action Plan to Address the Threat of Aquatic Invasive Species in Canada. In order to make efficient use of limited resources, priority species, vectors and locations needed to be determined. This was done in three workshops held in three zones in Canada: Pacific, Atlantic, and Central and Arctic zone. The Central and Arctic zone was defined as the fresh- and marine (Arctic) waters of Alberta, Saskatchewan, Manitoba, Ontario, Nunavut and the Northwest Territories, and the freshwaters of the St. Lawrence River in Quebec. Prior to the Central and Arctic zone workshop (held October 2007 in Burlington, Ontario), an online survey was developed to identify the scope of work being done on AIS monitoring. Information was sought on the types of efforts to directly or indirectly monitor AIS, what protocols are employed and what species are targeted. The results from 133 respondents from 51 organizations indicate that most of the AIS monitoring work is being conducted in Ontario and is targeting fishes. It is recognized that these results are likely due to a bias stemming from who the survey was sent to. The survey results also identified monitoring gaps and recommendations for AIS reporting.

RÉSUMÉ

La surveillance des espèces aquatiques envahissantes (EAE) adresse directement une des activités principales décrites dans le document intitulé Proposition de Plan d'action national de lutte contre les espèces aquatiques envahissantes. Afin d'utiliser les ressources limitées efficacement, les espèces, les vecteurs, et les endroits prioritaires doivent être déterminer. Ceci a été accompli pendant trois atelier tenu dans trois zones du Canada : Pacifique, Atlantique, et Centrale et Arctique. La zone Centrale et Arctique a été définie comme l'eux frais et marines d'Alberta, Saskatchewan, Manitoba, Ontario, Nunavut et les Territoires du Nord-Ouest, et les eaux frais du fleuve Saint-Laurent au Québec. Avant l'atelier de la zone Central et Arctique (tenu octobre 2007 à Burlington, Ontario), nous avons développer une enquête en ligne pour identifier le type de travail qui est compléter sur la surveillance des EAE. L'information a été cherchée sur les types d'efforts, direct ou indirect, qui surveillent les EAE, quels protocoles sont utilisés et quelles espèces sont visées. Les résultats de 133 répondants de 51 organisations indiquent que la majorité de surveillance des EAE est conduite à l'Ontario et vise les poissions. On reconnaît que ces résultats son probablement affecté par une polarisation relié a les personnes qui ont été envoyer l'enquête. L'enquête a aussi identifié les lacunes de surveillance et des recommandations pour le reportage des EAE.

1.0 INTRODUCTION

Fisheries and Oceans Canada (DFO), in support of the United Nations' Biological Diversity Convention and the Canadian Council of Fisheries and Aquaculture Minister's Aquatic Invasive Species Task Groups' National Action Plan (CCFAM-AISTG 2004), had developed an aquatic invasive species (AIS) program consisting of the following components: research, early detection/rapid repose, risk assessment and monitoring. In order to direct limited resources, priority species, vectors and locations needed to be identified across Canada. To do this, three zonal AIS monitoring workshops were held organized by DFO but included representatives from other federal and provincial governmental agencies, non-governmental agencies and academic institutions. The Atlantic zonal workshop was held in Moncton, New Brunswick in February 2006, the Pacific zonal workshop was held in Sidney, British Columbia in May 2006, and the Central and Arctic zonal workshop was held in Burlington, Ontario in October 2006.

For the purposes of the zonal AIS workshop, the Central and Arctic zone was defined as the fresh- and marine (Arctic) waters of Alberta, Saskatchewan, Manitoba, Ontario, Nunavut and the Northwest Territories, and the freshwaters of the St. Lawrence River in Québec.

In order to identify, prior to the workshop, the scope of the monitoring work being conducted in the Central and Arctic zone, it was decided to send out an online survey previously developed by the Ontario Ministry of Natural Resources (OMNR). The results of the survey were useful at the workshop to identify ongoing efforts, what agencies are involved in monitoring (directly or indirectly for invasive species), protocols employed and what species are targeted. The results of the survey are presented here along with the identification of AIS monitoring gaps and recommendations for AIS reporting.

For the purposes of this survey and resulting report, invasive (or invading) species were defined as non-native species whose introduction or spread threatens the environment, the economy, and/or society, including human health. Non-native (introduced, exotic or alien) species included plants, animals or micro-organisms that have been accidentally or deliberately introduced by humans into areas beyond their normal range (Ontario's Biodiversity Strategy 2005).

2.0 MATERIAL AND METHODS

The "Monitoring Aquatic Invasive Species Questionnaire" was designed by the OMNR and delivered on-line using SurveyMonkey (www.surveymonkey.com). The survey was made up of 26 questions, and multiple choice answers were provided for most questions (see Appendix A for complete survey). Questions were related to program description, data and logistics, and monitoring and detection of aquatic non-native species. The length of time needed to complete the survey was approximately 20 minutes.

The survey was first sent to Ontario recipients on November 10, 2005. It was available on-line for approximately six weeks. The distribution list was prepared in advance by identifying government and non-government organizations (NGO's) and contacts directly involved in on-going management or research of aquatic resources in Ontario (e.g., monitoring, assessment, inventory, etc.). The list was compiled from contacts known to the project leads, referrals and a website search for appropriate contacts from Ontario universities and colleges, non-profit environmental or conservation groups, other non-governmental organizations, conservation authorities, and federal and provincial government agencies, including numerous representatives from OMNR offices. Over 200 individuals from 67 organizations in Ontario were sent the survey.

The survey was subsequently sent out commencing August 15, 2006. It was sent to all the contacts from the 2005 Ontario distribution list in addition to others in the Central and Arctic zone involved with work in fresh- and marine (Arctic) waters of Alberta, Saskatchewan, Manitoba, Nunavut and the Northwest Territories, and the freshwaters of the St. Lawrence River in Québec. The opportunity was provided for surveys to be completed in French, and the answers were then translated into English and inputted into the online form.

Questions in the 2006 version of the survey were the same as the 2005 version with the exception of the multiple choice answers for questions 1 and 23. Question 1 stated "Please check the response that applies to the information being provided in this questionnaire". One of the three multiple choice answers in the 2005 version was "The information provided in this survey can be used for Ontario Ministry of Natural Resources purposes only". In the 2006 version, this answer was replaced with "The information provided in this survey can be used for Fisheries and Oceans Canada purposes only".

Question 23 stated "What do you do when you find aquatic non-native species (in a new area)?" Two of the six multiple choice answers were changed from the 2005 to the 2006 version. The text "Confirm identification" was replaced with "Contact the federal government"; while the text "Contact the Ontario Ministry of Natural Resources" was replaced with "Contact the provincial government".

3.0. RESULTS

3.1. NUMBER AND SOURCES OF SURVEYS COMPLETED

A total of 133 surveys were completed by 51 organizations throughout the DFO zone (Table 1). Some organizations completed more than one survey if they wanted to describe different programs. Of the 133 surveys, 14 (or 10%) were completed by DFO.

The province of Ontario had the highest number of both surveys completed (n=117) and organizations participating (n=39) compared to the other zones. No responses were received from Nunavut or the Northwest Territories.

Completed surveys were received from both government agencies and NGOs. Government participants were categorized into three levels: federal, provincial, regional (or conservation authorities), while NGO participants were categorized as representing universities, conservation (or environmental) groups, or other (Table 2). Participants from the provincial government (50) and universities (31) completed the largest number of surveys with most other organizations sharing a similar level of participation.

The survey results provided information on a wide range of aquatic-related activities and programs including fisheries assessments and surveys, habitat management, academic research, and monitoring of native species as well as non-native species. It should be noted that some surveys were incomplete and, therefore, the sample size may vary between questions. The following describes the responses given by the participants.

3.2 WHO'S WORKING ON AQUATIC NON-NATIVE SPECIES?

Of 125 surveys, 34% responded that their programs specifically target aquatic non-native species (4% were DFO programs), 58% answered they do not and 8% answered both yes and no. The frequency of responses for the different categories of government and NGO's are shown in Figure 1. There are disproportionately less programs specifically targeting aquatic non-native species in the provincial government when compared to other governments and NGO's; however, this result is likely an artefact of the large provincial government sample size.

Of the participants that answered their programs specifically target aquatic non-native species (n=52, including the 10 that answered both yes and no), 44% were from government agencies (DFO represents 13.5%), while 54% were from NGO's. University participants responded with the highest percentage of programs focussing on aquatic non-native species (39%) followed by provincial (21%) and federal (17%) government participants (Figure 2).

In Québec (freshwaters of the St. Lawrence River zone), 6 of the 8 surveys indicated that programs specifically target aquatic non-native species. These responses were

spread over the federal government (2), provincial government (1), universities (2) and conservation group (1).

In Ontario, 39% of participants (43 of 110) responded their programs specifically target aquatic non-native species: universities responded with the highest percentage of programs focussing on aquatic non-native species (42%), followed by the provincial government (23%).

In the western zone, 2 of the 6 surveys indicated that programs specifically target aquatic non-native species (DFO in Manitoba and the Alberta Biodiversity Monitoring Program).

3.3 HOW IS THE WORK BEING UNDERTAKEN?

The surveys which indicated that they target aquatic non-native species were examined for the type of sampling protocol being implemented. This information was gathered in question 12 (see Appendix A). Only a few respondents identified protocols specifically intended for aquatic non-native species. Four respondents answered that they use the procedure from the Invading Species Watch Program for monitoring zebra mussels (*Dreissena polymorpha*) and the spiny water flea (*Bythotrephes longimanus*) in Ontario waters. The program is a volunteer-based lake monitoring program delivered through a partnership between the Ontario Federation of Anglers and Hunters and the Ontario Ministry of Natural Resources (see www.invadingspecies.com). Other protocols reported were the Purple Loosestrife Biocontrol Monitoring Protocol, Standardized Ruffe (*Gymnocephalus cernuus*) Trawl for the Great Lakes, and the development of a rusty crayfish (*Orconectes rusticus*) protocol.

The activity most often implemented for targeted non-native species work was monitoring (65%), then research (60%), assessment/inventory (44%), and control (17%). In government programs (n=23), monitoring and assessment/inventory were primarily applied (37% and 23%, respectively), whereas NGO's (n=29) mostly reported research followed by monitoring (48% and 33%, respectively; Figure 3). Research was primarily carried out by universities. Few respondents reported the implementation of control activities for both the government or NGO's (8% and 10%, respectively).

A total of 47 non-native species were targeted by these activities, including 20 fishes, 12 invertebrates, 11 plants and 4 "other" (fish/waterborne pathogens, red eared sliders and mute swans). A complete list of species can be found in Appendix B.

The most highly targeted species groups were invertebrates and fishes (48% and 46% respectively; n=52; Figure 4). Of the respondents indicating their activities focused on invertebrates (n=25), 72% were carrying out research and 68% were monitoring. For fishes (n=24), 63% were monitoring and 46% were doing assessments or inventories (Figure 5). There was a small number of plant-focused programs (n=11), in which 82% were monitoring and 55% were research-oriented.

3.4 WHAT ELSE IS DONE IN AQUATIC ECOSYSTEMS NOT DIRECTLY RELATED TO NON-NATIVE SPECIES?

Information on organisms, or taxa involved in programs that do not specifically target aquatic non-native species was provided in 83 surveys (including those 10 that answered both yes and no to targeting these species in question #20). Across the Central and Arctic zone, the majority of these programs collect data on fishes and invertebrates (74% and 55%, respectively; Figure 6).

Results regarding the taxa acting as the main focus within an organization or type of organization are shown in Figure 7. DFO collects data primarily on fishes (4 of 6 responses) while almost 90% of responses from OMNR (n=37) indicated a focus on fish data collection with a smaller proportions of work being completed for other taxa. Most other types of organizations appear to include the majority of taxa, with the exception of mammals which are only covered by OMNR and regional agencies, and birds which are additionally covered by conservation groups.

The type of data collected for all taxa is shown in Figure 8. Across all taxa, species inventory data were most frequently collected, while abundance/density and community structure data were also often collected.

3.5 DETECTION AND REPORTING OF AQUATIC NON-NATIVE SPECIES

When asked whether aquatic non-native species had been incidentally detected in a program, almost 75% of respondents indicated yes, 18% no and 10% did not know (n=93; Figure 9). The frequency of responses for the different government and NGO categories are shown in Figure 10. There was no difference in the frequency at which aquatic non-native species were incidentally detected for the different categories (χ^2 = 5.7; $\chi^2_{0.05,5}$ = 11.1). Incidental detections were observed by 68 respondents and included 36 fish species, 12 invertebrates, 11 plants, and 2 "other" (virus, cyanobacterium; see Appendix C for a complete list). Greater than 50% of the 181 "incidental detections" were non-native fishes and approximately 33% were non-native invertebrates (Figure 11).

In question 23, participants were provided with multiple choice answers describing their potential reaction to finding an aquatic non-native species in a new area (Figure 12). Of the 114 who responded, 86% indicated that they would record the sighting, while 54% would preserve the specimen. Less than 40% indicated that they would report the information to the province (or call it into the Invading Species Hotline, 1-800-563-7711). Examples of "other" responses were to submit the information to OFAH, contact the Royal Ontario Museum (ROM) with a specimen for identification, and contact the United States Geological Service (USGS) (if capture occurred in American waters). Also, it appeared that individuals involved with bacterial pathogens and microscopic algae (phytoplankton) do not tend to notify the government; perhaps because these

organisms are not perceived as a priority and are difficult to identify as a native versus non-native species.

4.0 DISCUSSION

4.1 NUMBER AND SOURCES OF SURVEYS COMPLETED

The survey was completed to gain a better understanding of activities that target non-native species carried out in aquatic ecosystems in the DFO Central and Arctic zone. Results were intended to help evaluate the status of monitoring aquatic invasive species and the potential capacity of detecting them by gathering information from individuals involved with ongoing management, research, and assessment in aquatic ecosystems where they could encounter these species.

The 133 responses that were received are only a sample of all the aquatic activities occurring in the region. There is a bias in the representation of zones across the region because completed surveys predominantly represented activities in Ontario. This was likely due to the greater number of contacts in Ontario who were sent the survey. There were a small number of responses from western and St. Lawrence zones and no responses from Nunavut and Northwest Territories.

Environmental consulting firms (or alike) were also highly under-represented with only one survey completed by a for-profit NGO. The highest proportion of surveys was received from OMNR (35%), while less than a quarter were received from universities (23%). Federal and regional government respondents comprised 14% and 12%, respectively, whereas 11% of respondents represented conservation groups.

However, this project captured many of the current efforts occurring in the zone. A qualitative comparison of responses received in 2005 (n=76) with the cumulative responses (n=133) from 2005 (n=76) and 2006 (n=57) showed similar results. To achieve a more complete sample, a comprehensive contact list for the other potential recipients in the region plus a list for applicable businesses that are involved with aquatic field work would need to be compiled and these individuals should be sent the survey.

4.2. EXISTING ACTIVITIES IN AQUATIC ECOSYSTEMS

The taxon with the highest number of species covered by programs specifically targeting aquatic non-native species was fishes (20 species given), while the majority of programs not targeting non-native species were also collecting data on fishes. Invertebrates were the second most highly covered taxon. Plants and other groups of organisms such as mammals, birds and microorganisms did not appear to receive the same level of effort or attention from the groups that received and answered the survey;

although, these results could be expected as efforts were directed to acquiring aquatic information.

From an aquatic invasive species perspective, action is required to prevent the introduction of these species, which can threaten our environment, economy, and society (Ontario's Biodiversity Strategy 2005, CCFAM-AISTG 2004). Approximately one-third of those who responded to the survey indicated that they have programs in place specifically targeting aquatic non-native species. The main thrust of these programs was to study some aspect of these species, with 80% of respondents indicating that they monitor, assess/inventory, and/or research aquatic non-native species. Only 17% of the programs specifically targeting aquatic non-native species were classified by the respondents as being control programs (early detection/rapid response).

Early detection/rapid response programs (e.g., eradication, reduction, containment) were identified as an important component of aquatic invasive species management. Also important is obtaining the knowledge on which species may act as a potential invader and what areas are more susceptible to invasion. This can be applied to prevent or mitigate the potential effects of invasion. DFO's Centre of Expertise for Aquatic Risk Assessment (CEARA) is currently addressing this issue. However, responding to an invasion could be very effective if the invasive species is detected early, and if there is a single, isolated occurrence. Information on aquatic invasive species should be routinely collected, allowing for a timely response. The current distribution of monitoring, detecting and responding responsibilities across the various government agencies and NGO's should be examined and a clear guideline on roles and responsibilities should be created.

Although the majority of activities carried out in aquatic ecosystems are targeting native species, they can offer valuable information and an opportunity to detect or monitor for aquatic invasive species. Data collected on species inventory, abundance or density of fishes and invertebrates may reveal non-native species captures. It may not be possible to identify all non-native species immediately; however, a voucher specimen that can be later verified and reported to the appropriate agency is useful. The sooner a new species or a new occurrence is detected and reported, the sooner action can be taken.

4.3 DETECTION OF AQUATIC NON-NATIVE SPECIES

Results of the survey revealed that non-native species are frequently detected by accident in aquatic ecosystems. Activities not intended to sample or detect aquatic non-native species were found to do so approximately 70% of the time. Fishes showed the highest percentage of incidental detection, followed by invertebrates. The high rate of incidental non-native fish detection is likely due to the predominance of activities focused on fish sampling, as described in the results. Further investigation should consider whether this high detection rate is influenced by location, habitat, timing of activities, gear type and/or sampling protocols applied. Table 3 provides a list of the

protocols most frequently used in the incidental detection of non-native species. The majority of protocols are government-based and most are from OMNR.

It would be useful to determine the rate of incidental detection by the protocols listed in Table 3, and compare them to methods currently in place to detect aquatic invasive species. This may result in the creation of a new methodology or protocol which would incorporate both the needs of the existing program, and the need to detect non-native species. The possibility of meeting multiple objectives would be ideal in a situation where there are limited resources. At a January 2007 workshop on monitoring aquatic invasive species in Ontario involving representatives from OMNR's Fisheries Assessment Units, Great Lakes Management Units and the Ontario Aquatic Invasive Species Program, the need for a standardized method to collect information on smaller fishes in the nearshore communities, as well as detect non-native species was identified. Currently, OMNR has standardized methods in place for numerous fisheries assessment objectives, but there is no standardized method for monitoring invasive species. Although some programs do target non-native species, there is a lack of standardized sampling. One program in place is the OFAH-OMNR Invading Species Watch (see www.invadingspecies.org for more information).

4.4 REPORTING OCCURRENCES OF AQUATIC NON-NATIVE SPECIES

All new occurrences of a non-native species must be reported to the appropriate agency. In Ontario, occurrences should be reported to both the Invading Species Hotline and OMNR. Ideally, pertinent information is recorded, the specimen is preserved, the species is identified, and contact with the appropriate agency is made to relay this information.

Many participants indicated that their initial reaction included recording their sighting (86%) and preserving the specimen (54%). A general lack of awareness of the proper steps has been identified, and must be addressed (Ontario Ministry of Natural Resources 2006). Participants at the OMNR workshop noted that additional guidance is needed when reporting a sighting (e.g., how many occurrences of a given species is wanted for the same location? should only the first occurrence be reported? or all occurrences?). As well, participants noted that a list of priority or key species should be identified and distributed.

In response to this suggestion, a field guide for identification, vouchering and reporting of priority aquatic invasive species in Ontario is underdevelopment by OMNR with help from several partners, including DFO. Monitoring aquatic ecosystems for non-native or invading species is a critical component of any early detection and rapid response system. The responses from this survey indicated that whether or not programs are focused on aquatic non-native species, the individuals detecting these species need to be made aware of the course of action that should be taken following detection.

4.5 SUMMARY

This project has provided an overview of the current efforts focused on aquatic invasive species occurring in the DFO Central and Arctic zone. We have revealed that the majority of programs targeting both native and non-native species were focused on fishes; however, we do acknowledge that this representation is slightly biased as efforts were focussed on acquiring information on aquatic invasive species. Approximately one-third of those who responded to the survey indicated that their organization is currently running programs that target aquatic non-native species. The majority of these programs focussed on monitoring and creating inventories, while a small percentage of the programs were considered to be control programs. The lack of active early detection/rapid response programs was highlighted as a critical gap in the study of aquatic invasive species. In addition, it was noted that there is a lack of knowledge of the proper steps which need to be taken when a researcher detects an aquatic invasive species. To this end, the OMNR, in collaboration with DFO, is completing a field guide of priority aquatic invasive species in Ontario.

5.0 ACKNOWLEDGEMENTS

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Table 1. Total number of surveys completed and organizations participating in the "Monitoring Aquatic Invasive Species Questionnaire 2005, 2006".

	Central & Arctic Zone	Ontario	Western (Alberta, Saskatchewan, Manitoba)	Freshwaters of the St. Lawrence River (Québec)	Nunavut & Northwest Territories
Surveys completed	133	117	6	10	0
Organizations completing surveys	51	39	5	7	0

Table 2. Total number surveys completed by both governmental and non-governmental participants in the DFO Central and Arctic Zone (excluding Nunavut and Northwest Territories).

Number of organizations (no. of surveys)	Central & Arctic Zone	Ontario	Western (Alberta, Saskatchewan, Manitoba)	Freshwaters of the St. Lawrence River (Québec)
Government	**20 (86)**	16 (79)	2 (2)	2 (5)
Federal	2 (19)	2 (15)	1 (1)	1 (3)
Provincial	4 (50)	2 (47)	1 (1)	1 (2)
Regional	12 (17)	12 (17)	0	0
Non-government	**31 (47)**	23 (38)	3 (4)	5 (5)
Universities	16 (31)	14 (29)	0	2 (2)
Conservation groups	14 (15)	8 (8)	3 (4)	3 (3)
Other	1 (1)	1 (1)	0	0

Table 3. Protocols most frequently used to detect incidental aquatic non-native species.

Protocol	# Times Identified
Near Shore Community Index Netting (NSCIN)	6
Ontario Stream Assessment Protocol (OSAP)	6
Fall Walleye Index Netting (FWIN)	6
End of Spring Trap Net (ESTN)	5
Spring Profundle Index Netting (SPIN)	4
Spring Littoral Index Net (SLIN)	4
Creel surveys	4
Ontario Benthos Biomonitoring Network protocol (OBBN)	3
Marsh Monitoring Protocol	3

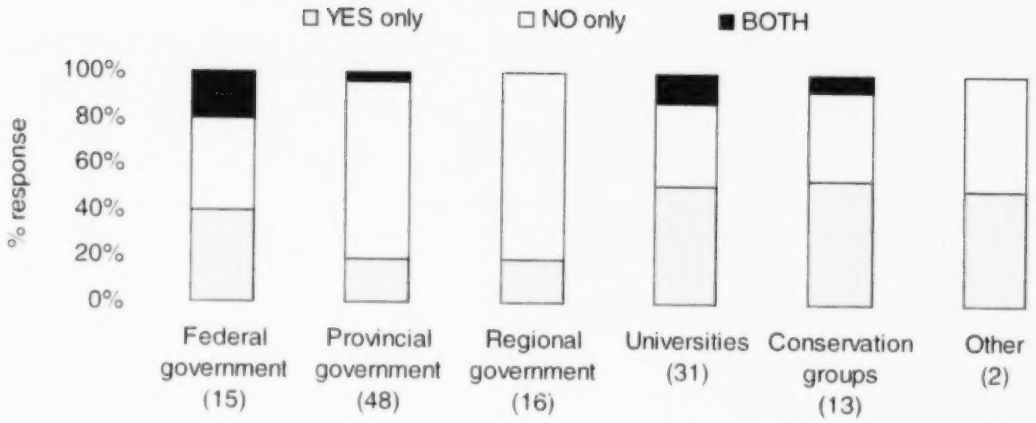

Figure 1. Responses by organization as to whether or not their programs specifically target aquatic non-native species (n).

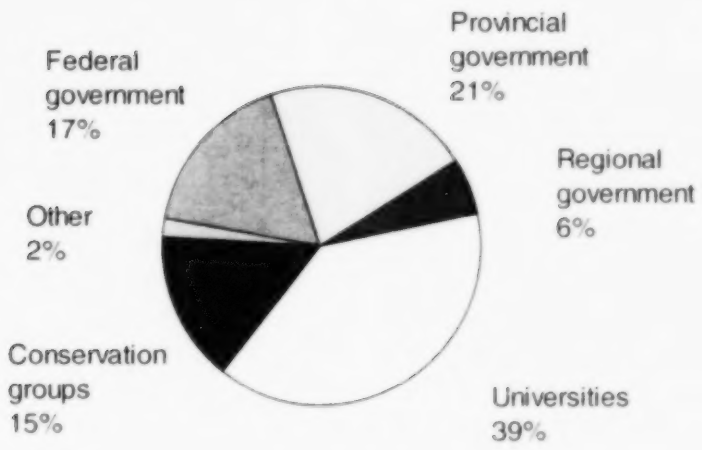

Figure 2. Distribution of programs which specifically target aquatic non-native species (n=52) by government and non-government organizations.

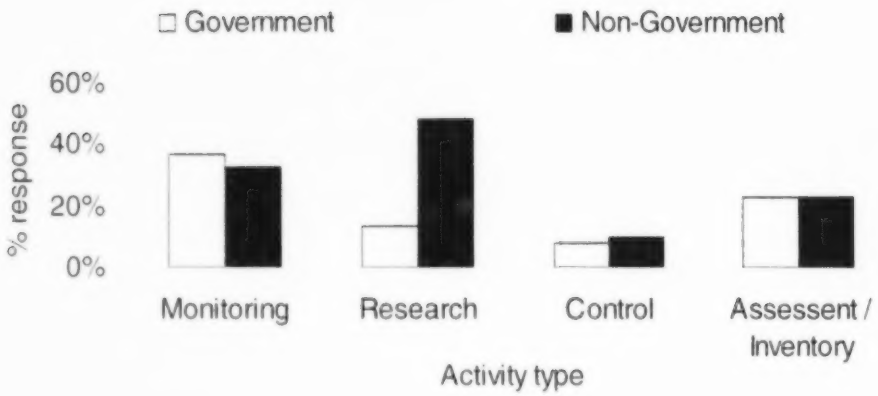

Figure 3. Frequency of responses from government (n=23) and non-government organizations (n=29) indicating the types of activities targeting aquatic non-native species.

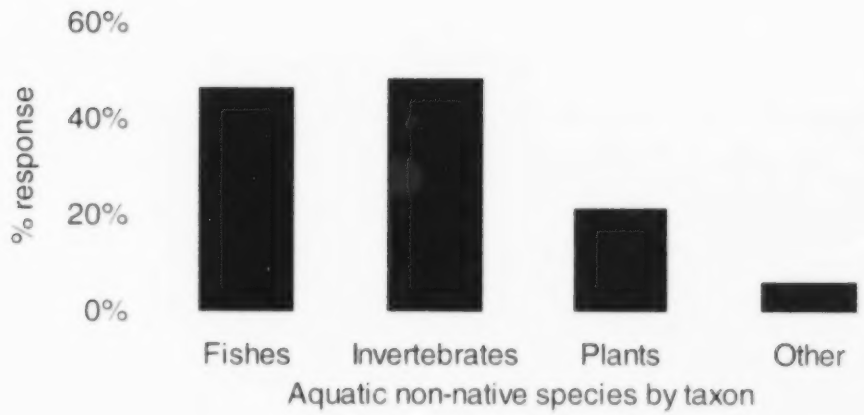

Figure 4. Frequency of responses indicating the aquatic non-native species taxon targeted by monitoring, research, control, and assessment/inventory activities (n=52).

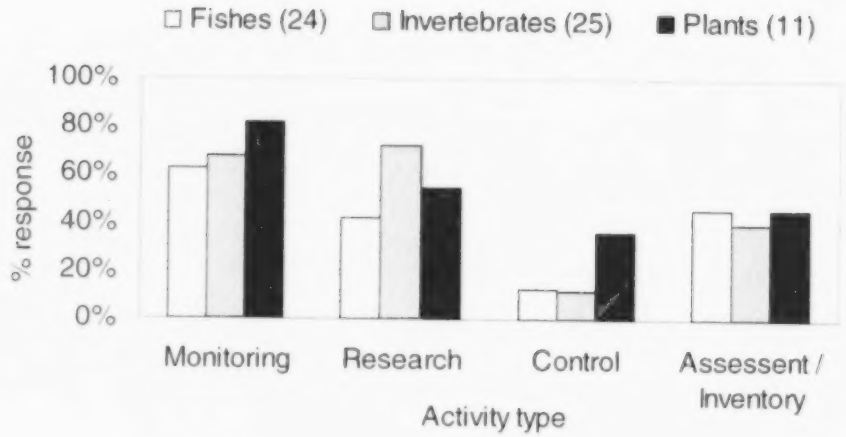

Figure 5. Frequency of responses describing the specific type of activity targeting non-native fishes, invertebrates and plants (n).

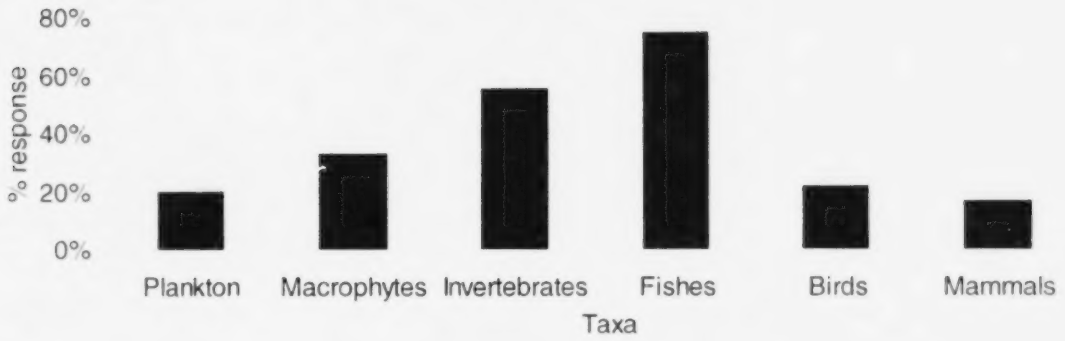

Figure 6. Frequency of responses indicating the taxon for which information was collected in programs that do not specifically target aquatic non-native species (n=83).

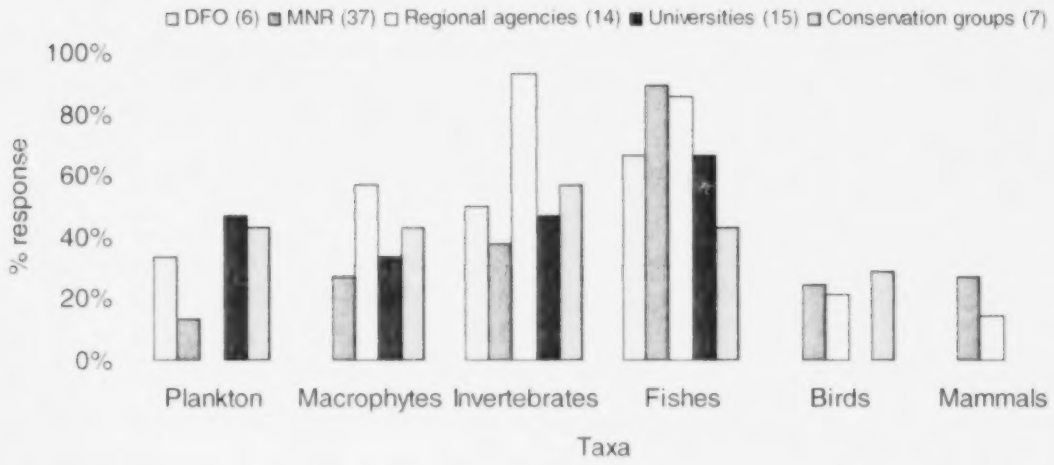

Figure 7. Frequency of responses describing the taxa for which information was collected in programs that do not specifically target aquatic non-native species for government and non-government organizations (n).

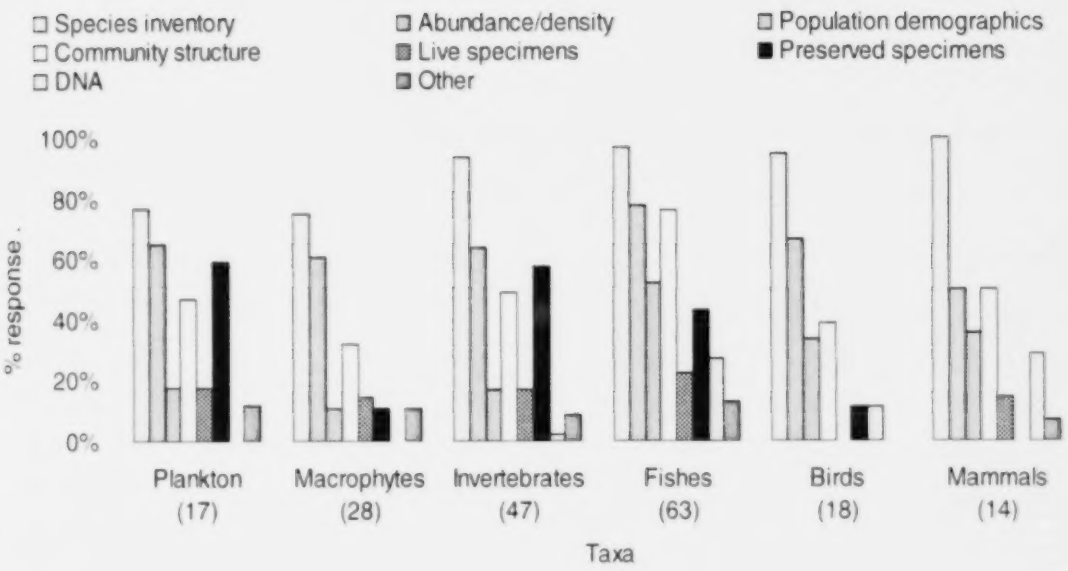

Figure 8. Frequency of responses describing the taxa and type of data collected for each taxon in programs that do not specifically target aquatic non-native species (n).

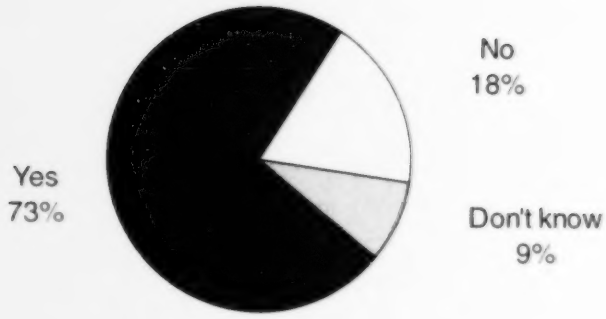

Figure 9. Distribution of responses indicating whether aquatic non-native species had been incidentally detected (n=93).

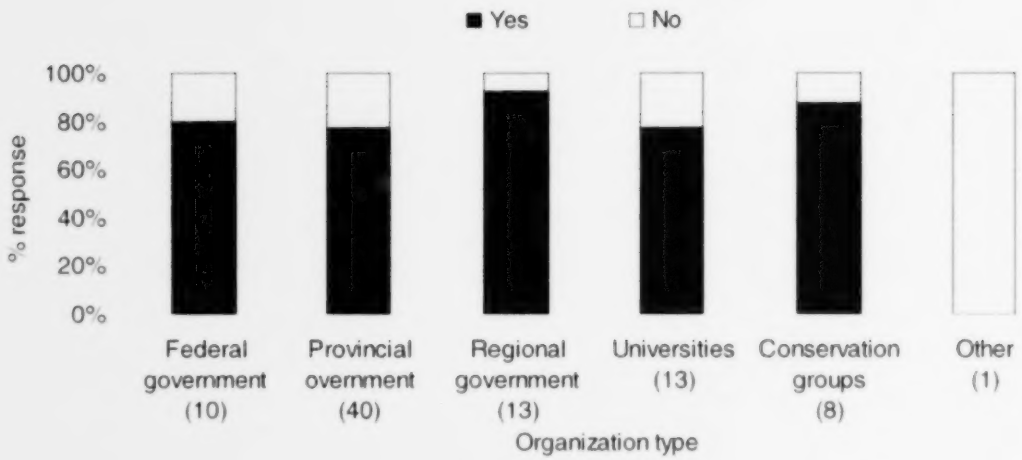

Figure 10. Frequency of responses by government and non-government organizations describing whether aquatic non-native species had been incidentally detected in their programs (n).

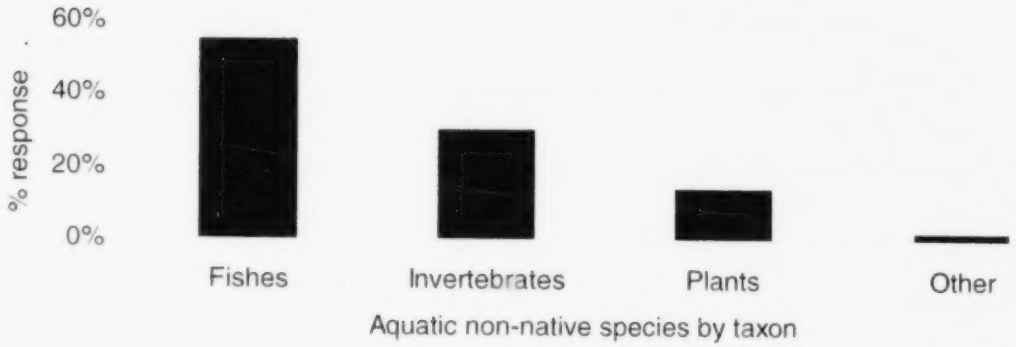

Figure 11. Frequency of responses indicating the taxon of aquatic non-native species incidentally detected (n=68).

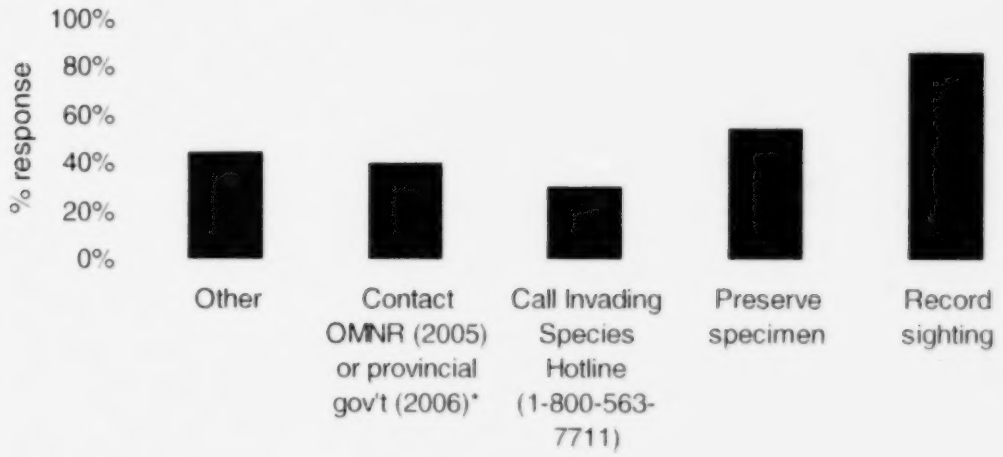

Figure 12. Frequency of responses indicating the actions taken when aquatic non-native species were found in a new area (n=114).

* 2005 Survey contained "Contact OMNR" while the 2006 Survey contained "Contact provincial government" in its place: the responses from both years were pooled. Also, the 2005 Survey contained "Confirm ID" while the 2006 Survey contained "Contact the federal government" in its place: those responses were excluded from the figure.

APPENDIX A. MONITORING AQUATIC INVASIVE SPECIES SURVEY 2005-2006

1. INTRODUCTION

The Ontario Ministry of Natural Resources (in 2005 or Fisheries and Oceans Canada in 2006) is seeking information about aquatic ecosystem monitoring and assessment activities occurring in Ontario waters (in 2005 or Central and Arctic Region in 2006) that may detect aquatic invasive species. Your assistance in completing this questionnaire with information about activities carried out by you or your organization, even if they are not intended to detect aquatic invasive species, is appreciated.

For the purposes of this questionnaire, invading (or invasive) species are non-native species whose introduction or spread threatens the environment, the economy, and/or society, including human health. Examples of invading species are zebra mussel, round goby, purple loosestrife, and Eurasian water milfoil. Non-native (introduced, exotic or alien) species are plants, animals or micro-organisms that have been accidentally or deliberately introduced by humans into areas beyond their normal range.

There are six sections and a total of 26 questions in this questionnaire, which takes about 20 minutes to complete. If there are questions you do not wish to answer, you can leave them blank and move on to the next question. There is a section on page 5 for any additional information or comments you wish to include.

Before submitting your information, you may review or change it. Select "Previous" or "Next" to access different pages of the questionnaire. If you wish to return to the questionnaire at another time to complete it, select "Next" which will bring you to the next page and save your information on previous pages when you "EXIT Questionnaire". You can access your information again from the same computer through the web link you used to reach this page.

By selecting "SUBMIT QUESTIONNAIRE" on the last page 6, you complete the questionnaire and submit it as final.

If you wish, you may complete and submit more than one questionnaire (e.g. if you want to provide information for each project or program, if you have several, in separate questionnaires).

2. PROGRAM DESCRIPTION

1. Please check the response that applies to the information being provided in this questionnaire.

   - ❑ The information provided in this questionnaire can be available to the public if required.
   - ❑ The information provided in this questionnaire can be used for Ontario Ministry of Natural Resources purposes only. (2005 Questionnaire)
   - ❑ The information provided in this questionnaire can be used for Fisheries and Oceans Canada purposes only. (2006 Questionnaire)
   - ❑ Other (please specify)

2. Please provide information on the agency/organization you represent.

   Agency/Organization name, Mailing address, City/Town, Province, Postal code

3. Please provide a brief description of your program.

   Program name, Start date, End date, Geographic coverage, Brief description (type, species, habitat, etc.), Contact name, Contact telephone number, Contact email address

4. How is the work in your program carried out?

   - ❑ Internally
   - ❑ Externally (e.g. contracted out)
   - ❑ Through partnerships
   - ❑ Other (please specify)

5. For work that is performed internally by paid staff, what human resources are used?

# Staff	Hours	Commitment
❑ <5	❑ Full-time	❑ Permanent
❑ 5-10	❑ Part-time	❑ Temporary/contract
❑ 11-20	❑ All of the above	❑ All of the above
❑ >20	❑ None of the above	❑ None of the above

6. For work that is performed by volunteers, what human resources are used?

# Volunteers	Duration	Commitment
❑ <5	❑ Seasonal	❑ Usually same group of people
❑ 5-10	❑ Year-round	❑ Sometimes the same people sometimes new people
❑ 11-20	❑ All of the above	❑ Usually new people
❑ 21-30	❑ None of the above	❑ None of the above
❑ 31-40		
❑ 41-50		
❑ >50		

7. For work that is conducted externally or through partnerships, please list the agencies/organizations involved including the type of partnership (paid, matched funding, recurring).

3. DATA & LOGISTICS

8. What aquatic habitat does your work cover?

- ❑ Wetland
- ❑ Coastal
- ❑ Great Lakes
- ❑ Inland lakes
- ❑ Riverine
- ❑ Other (please specify)

9. What type of information is collected?

- ❑ Biological
- ❑ Chemical
- ❑ Physical
- ❑ Spatial
- ❑ Other (please specify)

10. What data is collected if biological? (Please check all that apply.)

	Plankton	Macrophytes	Invertebrates	Fishes	Birds	Mammals	Other
Species inventory							
Abundance/density							
Population demographics							
Community structure							
Live specimens							
Preserved specimens							
DNA							

Other

11. If you selected "Other" in the previous question #10 please specify below; if you did not proceed to the following question #12.

12. Is there a sampling protocol used? (E.g. FWIN EMAN ELC etc.)

- ❑ Yes
- ❑ No
- ❑ Don't know
- ❑ If yes please list the protocol(s) used.

13. What is the timing of data collection?

- ❑ Winter
- ❑ Spring
- ❑ Summer
- ❑ Fall
- ❑ Other (please specify)

14. What is the frequency of data collection?

- ❑ Daily
- ❑ Weekly
- ❑ Monthly
- ❑ Annually
- ❑ Other (please specify)

15. How is the data stored?

- ❑ Digitally/electronically
- ❑ As hard copy

16. In what format is data stored if digitally/electronically?

- ❑ Access database
- ❑ Excel spreadsheet
- ❑ Word document
- ❑ GIS database
- ❑ Other (please specify, e.g. FishNet, SOLARIS, NHIC, etc.)

17. Is data you collect available to individuals outside of your agency/organization?

- ❑ Yes
- ❑ No
- ❑ Don't know
- ❑ Other (please specify)

18. Do you have a data sharing agreement?

- ❑ Yes
- ❑ No
- ❑ Don't know
- ❑ If yes, with who?

19. Are reports produced?

- ❑ Yes
- ❑ No
- ❑ Don't know
- ❑ If yes, who can access them?

4. MONITORING

20. Does your program specifically target aquatic non-native species?

- ❑ Yes (go to question #22)
- ❑ No (go to next question #21, then #23)

21. Have aquatic non-native species been incidentally detected in your program?

- ❑ Yes
- ❑ No
- ❑ Don't know
- ❑ If yes, please list the species.

22. Please list the aquatic non-native species targeted for each type of activity below that applies to your program.

- ❑ Monitoring
- ❑ Research
- ❑ Control
- ❑ Assessment/Inventory
- ❑ Other (please specify)

23. What do you do when you find aquatic non-native species (in a new area)?

- ❑ Record sighting
- ❑ Preserve specimen
- ❑ Confirm identification (OMNR 2005 Questionnaire) / Contact the federal government (DFO 2006 Questionnaire)
- ❑ Call the Invading Species Hotline (1-800-563-7711)
- ❑ Contact the Ontario Ministry of Natural Resources (OMNR 2005 Questionnaire) / Contact the provincial government (DFO 2006 Questionnaire)
- ❑ Other (please specify)

24. Would you be willing to report observations of aquatic non-native species if you were provided with a list of key species and identification features to watch for?

- ❑ Yes
- ❑ No
- ❑ Don't know
- ❑ If no, why not?

5. ADDITIONAL INFORMATION

25. If we require additional details or information about your program who can we contact (if different from the contact in question #3)?

Name, Telephone number, Email address, Other information

26. Please use the space below to provide any additional information or comments you wish to include with the questionnaire.

6. THANK YOU!

By selecting "SUBMIT QUESTIONNAIRE", you finalize the questionnaire and submit it.

If you wish to make changes or review your information, select "Previous" to view the previous pages and edit, or you can "EXIT Questionnaire" and re-access it later from the same computer to complete it.

We thank you for your time and participation. Any inquiries about this questionnaire can be directed to (in 2005) Keiko Lui, Introductions Biologist Project Analyst (MNR), at 705-755-1948 or (in 2006) Becky Cudmore, Freshwater Research Biologist, at 905-336-4474.

We also invite you to call the Invading Species Hotline at 1-800-563-7711, or visit us online at www.invadingspecies.com, to get more information on and report sightings of invading species.

APPENDIX B. LIST OF AQUATIC NON-NATIVE SPECIES TARGETED

The following species (in alphabetical order by scientific name) were provided in responses for question #22, in the Monitoring Aquatic Invasive Species Questionnaire 2005-2006, asking respondents to list the aquatic non-native species targeted through their programs.

Species targeted Common name	Scientific name	Taxon
alewife	*Alosa pseudoharengus*	fish
rock bass	*Ambloplites rupestris*	fish
goldfish	*Carassius auratus*	fish
grass carp	*Ctenopharyngodon idella*	fish
common carp	*Cyprinus carpio*	fish
western mosquitofish	*Gambusia affinis*	fish
eastern mosquitofish	*Gambusia holbrooki*	fish
ruffe	*Gymnocephalus cernuus*	fish
smallmouth bass	*Micropterus dolomieu*	fish
largemouth bass	*Micropterus salmoides*	fish
white perch	*Morone americana*	fish
round goby	*Neogobius melanostomus*	fish
rainbow trout	*Oncorhynchus mykiss*	fish
Chinook salmon	*Oncorhynchus tshawytscha*	fish
rainbow smelt	*Osmerus mordax*	fish
sea lamprey	*Petromyzon marinus*	fish
tubenose goby	*Proterorhinus marmoratus*	fish
walleye	*Sander vitreus*	fish
tench	*Tinca tinca*	fish
common bithynia	*Bithynia tentaculata*	invertebrate
spiny waterflea	*Bythotrephes longimanus*	invertebrate
fishhook waterflea	*Cercopagis pengoi*	invertebrate
Oriental mystery snail	*Cipangopaludina chinensis*	invertebrate
quagga mussels	*Dreissena bugensis*	invertebrate
zebra mussels	*Dreissena polymorpha*	invertebrate
amphipod	*Echinogammarus ischnus*	invertebrate
Chinese mitten crab	*Eriocheir sinensis*	invertebrate
freshwater bryozoan	*Lophopodella carteri*	invertebrate
rusty crayfish	*Orconectes rusticus*	invertebrate
New Zealand mudsnail	*Potamopyrgus antipodarum*	invertebrate
European stream valvata	*Valvata piscinalis*	invertebrate
flowering rush	*Butomus umbellatus*	plant
fanwort	*Cabomba caroliniana*	plant
reed sweet grass	*Glyceria maxima*	plant
water thyme	*Hydrilla verticillata*	plant
European frog bit	*Hydrocharis morsus-ranae*	plant
purple loosestrife	*Lythrum salicaria*	plant

parrot feather water milfoil	*Myriophyllum aquaticum*	plant
Eurasian water milfoil	*Myriophyllum spicatum*	plant
reed canary grass	*Phalaris arundinacea*	plant
common reed	*Phragmites australis*	plant
curly leaf pondweed	*Potamogeton crispus*	plant
mute swans	*Cygnus olor*	bird
red-eared sliders	*Trachemys scripta*	reptile

Others (general)

non-native fish pathogens
non-native plankton
salmonids - illegally stocked
basses- illegally stocked
crayfish
estuarine invertebrates
Ponto-Caspian invertebrates

APPENDIX C. LIST OF AQUATIC NON-NATIVE SPECIES INCIDENTALLY DETECTED

The following species (in alphabetical order by scientific name) were provided in responses for question #21, in the Monitoring Aquatic Invasive Species Questionnaire 2005-2006, asking respondents to list the aquatic non-native species incidentally detected in their programs.

Aquatic non-native species incidentally detected

Common name	Scientific name	Taxon
alewife	*Alosa pseudoharengus*	fish
rock bass	*Ambloplites rupestris*	fish
yellow bullhead	*Ameiurus natalis*	fish
American eel	*Anguilla rostrata*	fish
central stoneroller	*Campostoma anomalum*	fish
goldfish	*Carassius auratus*	fish
slimy sculpin	*Cottus cognatus gracilis*	fish
spoonhead sculpin	*Cottus ricei*	fish
grass carp	*Ctenopharyngodon idella*	fish
common carp	*Cyprinus carpio*	fish
koi	*Cyprinus carpio*	fish
gizzard shad	*Dorosoma cepedianum*	fish
northern pike	*Esox lucius*	fish
banded killifish	*Fundulus diaphanus*	fish
ruffe	*Gymnocephalus cernuus*	fish
northern hogsucker	*Hypentelium nigricans*	fish
longnose gar	*Lepisosteus osseus*	fish
green sunfish	*Lepomis cyanellus*	fish
bluegill	*Lepomis macrochirus*	fish
smallmouth bass	*Micropterus dolomieu*	fish
largemouth bass	*Micropterus salmoides*	fish
white perch	*Morone americana*	fish
white bass	*Morone chrysops*	fish
greater redhorse	*Moxostoma valenciennesi*	fish
round goby	*Neogobius melanostomus*	fish
coho salmon	*Oncorhynchus kisutch*	fish
rainbow trout	*Oncorhynchus mykiss*	fish
Chinook salmon	*Oncorhynchus tshawytscha*	fish
rainbow smelt	*Osmerus mordax*	fish
sea lamprey	*Petromyzon marinus*	fish
white crappie	*Pomoxis annularis*	fish
black crappie	*Pomoxis nigromaculatus*	fish
Atlantic salmon	*Salmo salar*	fish
brown trout	*Salmo trutta*	fish
rudd	*Scardinius erythrophthalmus*	fish
spiny water flea	*Bythotrephes longimanus*	invertebrate

fishhook water flea	*Cercopagis pengoi*	invertebrate
Oriental mystery snail	*Cipangopaludina chinensis*	invertebrate
water flea	*Daphnia lumholtzi*	invertebrate
quagga mussel	*Dreissena bugensis*	invertebrate
zebra mussels	*Dreissena polymorpha*	invertebrate
amphipod	*Echinogammarus spp.*	invertebrate
Chinese mitten crab	*Eriocheir sinensis*	invertebrate
papershell crayfish	*Orconectes immunis*	invertebrate
rusty crayfish	*Orconectes rusticus*	invertebrate
New Zealand mudsnail	*Potamopyrgus antipodarum*	invertebrate
banded mystery snail	*Viviparus georgianus*	invertebrate
flowering rush	*Butomus umbellatus*	plant
fanwort	*Cabomba caroliniana*	plant
water hyacinth	*Eichornia crassipes*	plant
reed sweet grass	*Glyceria maxima*	plant
giant hogweed	*Heracleum mantegazzianum*	plant
little hogweed	*Portulaca oleracea*	plant
European frog-bit	*Hydrocharis morsus-ranae*	plant
yellow iris	*Iris pseudacorus*	plant
purple loosestrife	*Lythrum salicaria*	plant
Eurasian water milfoil	*Myriophyllum spicatum*	plant
watercress	*Nasturtium officinale*	plant
curly leaf pondweed	*Potamogeton crispus*	plant
cyanobacterium	*Cylindrospermopsis raciborski*	other
viral hemorrhagic septicemia		other